A02 Long-term evolution of mid-latitude ice and mixed-phase cloud properties and their radiative effects from geostationary satellite observations

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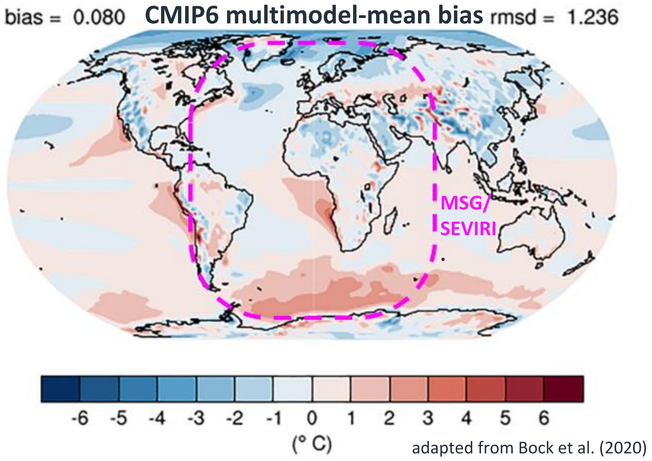
Motivation



CMIP6 multimodel-mean (1995–2014) of the **annual mean near-surface (2 m) air temperature** compared to ERA5 shows significant bias, with the still inaccurate model representation of clouds – especially mixed-phase clouds – being a major contributor. **Cloud thermodynamic phase** and cloud phase transitions are critical in understanding the **earth radiation budget**, the hydrological cycle, and atmospheric processes. It is unclear how cloud properties will change in a changing climate since cloud feedbacks constitute the highest contribution to the uncertainty in climate projections.

Collaborations within TPChange

- **A01** Evaluation of MSG observations with in situ data
- **B03** Evaluation of model simulations of convection with spaceborne observations
- **B08** Analysis of WCBs simulations with MSG data
- **A04** Joint investigation of cirrus clouds during TPEx II
- **C01** Combination of ice supersaturation and cirrus cloud life cycles observed with MSG
- **C03** Convective overshooting
- **Z03, Z02, Z01** Evaluation of cloud properties, cloud evolution and radiative effects in mid-latitudes in high resolution models, in reanalysis data and global climate models and provision of satellite observations during airborne campaigns.

Results from phase I

ProPS: Probabilistic cloud top Phase for SEVIRI

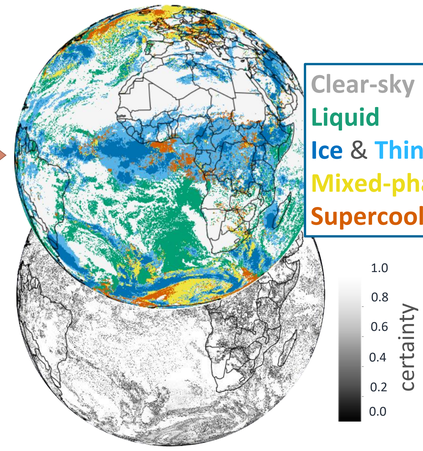
Bayesian approach: Mayer et al., AMT, 2024a, 2024b

$$P(q|M,A) = \frac{1}{N} \prod P(M_i \mid q, C_i)\ P(q|A)$$

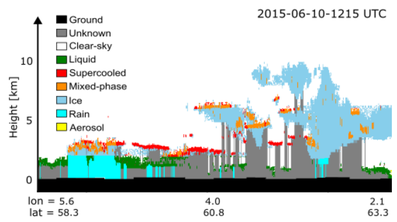
Mayer et al., RS, 2023

MSG/ SEVIRI

$BT_{10.8\mu m}$ & $BT_{10.8\mu m} - BT_{8.7\mu m}$ & $BT_{10.8\mu m} - BT_{12\mu m}$ & $R_{1.6\mu m}$ & $R_{1.6\mu m}/R_{0.6\mu m}$ & ancillary data

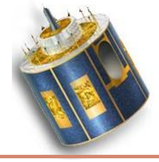


DARDAR-CLOUD: **Active** synergistic Lidar-Radar cloud product from A-Train

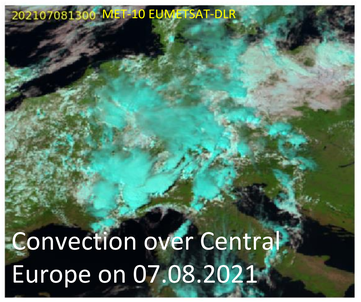


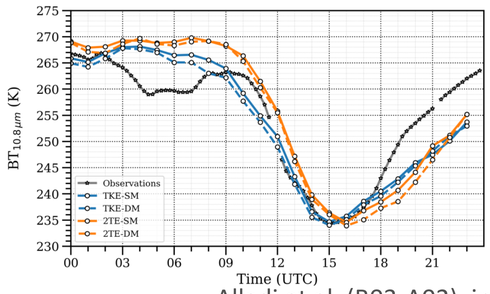
Collocations

MSG/SEVIRI: **Passive** geostationary imager with 12 channels and 3 x 3 km^2 spatial resolution at nadir



Evaluation of the temporal evolution of **WCBs** and **deep convective** clouds in high-resolution models





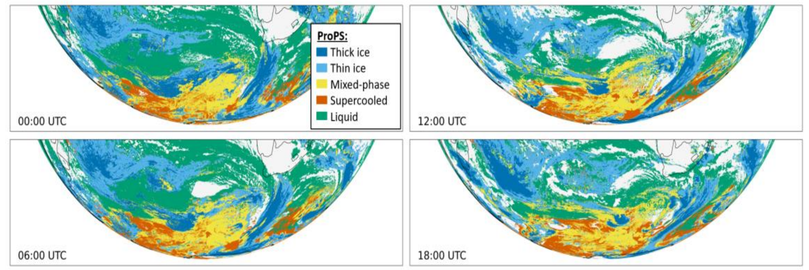
Alladi et al. (B03-A02), in prep.

Research plan phase II

Main goal: Meteosat observations of ice and mixed-phase clouds over the Southern Ocean in the last 20+ years will be used to evaluate cloud phase and radiation in climate models.

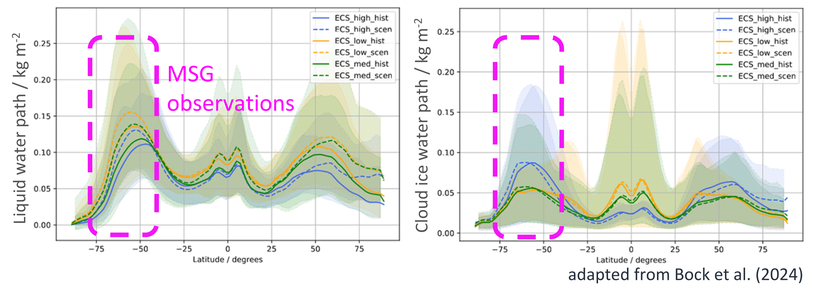
1. Derivation of the frequency of **occurrence**, **microphysical** and **macrophysical** properties of **ice**, **mixed-phase** and **supercooled** clouds over the Southern Ocean during the last **23 years**

2. Improved understanding of cloud **properties**, especially cloud top phase, and cloud property temporal **evolution** on **top-of-atmosphere radiation** in the **Southern Ocean**



A short time series (00, 06, 12, 18 UTC) of cloud top phase evolution on 01.01.2022 over the Southern Ocean derived with the MSG retrieval ProPS.

3. **Comparison** of cloud microphysical and radiative properties and their trends to **GCM** simulations (CMIP) using the ESMValtool in collaboration with the DLR Earth System Model Evaluation and Analysis Department



adapted from Bock et al. (2024)

Comparison of cloud properties between CMIP6 models grouped by effective climate sensitivity (ECS) for historical and future scenario simulations.